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SMALL BEACH EROSION CONTROL PROJECT

PLUM ISLAND, MASSACHUSETTS

RECONNAISSANCE REPORT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS 02154

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RECONNAISSANCE REPORT
BEACH EROSION CONTROL STUDY
PLUM ISLAND, MASSACHUSETTS

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RECONNAISSANCE REPORT
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PLUM ISLAND, MASSACHUSETTS

1. Authority. This Reconnaissance Report is made in response to the joint request of 12 July 1966 from the City of Newburyport and Town of Newbury, Massachusetts. The study is undertaken in accordance with the authority granted under Section 103a of the River and Harbor Act of 1962, as amended by Section 310 of the River and Harbor Act of 1965.

2. Purpose. The purpose of this report is to determine the economic justification and practical feasibility of making a detailed beach erosion control study for protective improvements pursuant to the Small Beach Erosion Control Authority provided by Section 103 of the 1962 River and Harbor Act as amended.

3. Prior Reports. A beach erosion control report for Plum Island was completed in 1952 by the Corps of Engineers in cooperation with the Commonwealth of Massachusetts and is published as House Document No. 243, 83d Congress, 2d Session. This report recommended no Federal participation in the cost of beach erosion control improvements for this area due to the private nature of shorefront ownership at that time. It did, however, recommend that protective measures undertaken by local interests, based on their determination of economic justification be accomplished in accordance with a method developed in the study, namely, placement of about 285,000 c.y. of sand fill along the beach and raising the shore end of the south jetty at the Merrimac River to 16 feet above mean low water. In addition to other reports made for adjacent areas as listed in the aforementioned House Document, beach erosion control studies have been completed for the entire coast (16 miles) of the State of New Hampshire, including a modification to the Federal beach erosion project for Hampton Beach. The Hampton Beach Project was constructed in 1955 (sand fill) and modified by construction of an impermeable groin and periodic nourishment of sand from Hampton Harbor in 1965. Wallis Sands State Beach, which was recommended for Federal participation in the cost of construction in the beach erosion control study for the State of New Hampshire was constructed in 1963. A design memorandum on Rehabilitation of the North and South Jetties at the entrance to the Merrimac River was completed in 1965, and it is planned to initiate construction in 1967 with first priority given to the construction of the south jetty.

4. Description. The seaward shoreline of Plum Island is about 8 miles in length. Plum Island is a sandy coastal barrier bar largely covered with dunes along its southern two thirds ranging as high as 50 feet above mean sea level. The bar is separated from the Plum Island River to the west by a width of marsh generally greater than that of the bar. The bar generally varies in width between one tenth and four tenths of a mile, averaging one fourth of a mile in the area south of the Basin, a body of water extending southward from the Merrimac River Estuary. The width of the bar at its narrowest point is about 350 feet, but widens to its maximum width of about six tenths of a mile at the Merrimac River. Development, concentrated at the northern portion of the island within the limits of the City of Newburyport and the Town of Newbury, consists of cottages, churches, commercial establishments and a United States Coast Guard Station. The remainder of the island to the south with minor exceptions, is a Federal Wildlife Sanctuary operated by the U.S. Fish and Wildlife Service. Access between the mainland and the island is furnished by the Plum Island Turnpike which runs from the City of Newburyport to Northern Boulevard, the only surfaced road on Plum Island leading to the northern development. The area under study is shown on United States Coast and Geodetic Survey Charts 213 and 1206 and the Newburyport East Quadrangle of the United States Geological Survey.

5. Statement of the Problem and Improvement Desired.

The problem is generally a continuation of that which was found in the previous survey study of 1952, namely, progressive erosion of the shorefront seaward of cottages fronting Northern Boulevard. This erosion is particularly severe during major storms resulting in losses of cottages, serious reduction in lot sizes, and total loss of some seaward lots. Many cottages have been moved landward as far as possible and are now bordering the boulevard. Normal high tides now approach backshore dunes and embankments along much of the problem area, which is becoming more and more vulnerable to storm erosion. Local interests have become increasingly concerned with the seriousness of the problem and desire engineering and financial assistance from the State and Federal Government in correcting the problem. A more detailed discussion of the problem is given in Appendix A. See photos 1 through 24 consisting of detailed pictures portraying the problem.

FACTORS PERTINENT TO THE PROBLEM

6. Geomorphology. The island is glacial in origin which is vividly demonstrated by the existence of drumlin formations at the southeast tip of the island. The island has been shaped by a combination of tidal and wave induced erosive processes combined with wind blown materials forming dunes as high as 50 feet.

7. Littoral Materials.

a. Characteristics. Visual inspection and information obtained from the prior study disclosed that beach material is generally of medium texture. As would be expected, material in the dunes is a mixture of fine and medium sand. Samples which were taken at the mouth of the Merrimac River and offshore from the north end of Plum Island indicate that offshore material is coarser than the beach material. Median diameters of the material along the foreshore exceed .40 mm but not greater than about 1.0 mm., which is commensurate with good beach sand.

b. Sources. Glacial deposits constitute the major source of beach materials. The drumlins and dune formation along the southern shorefront are a natural source of materials and are subjected to serious erosion during frequent storms when overtopping of the backshore occurs. The offshore submarine bar extending across the mouth of the Merrimac River demonstrates the movement of material from the beach areas lying north of the Merrimac River during northeast storms and material from the south during southeast storms.

8. Littoral Forces.

a. Waves. Wave studies based on hindcast studies utilizing both the Penobscot Bay Station, Maine and the Nauset Beach Station, Cape Cod, Massachusetts, as outlined in Beach Erosion Board Technical Memorandum 55, indicate the maximum energy producing swells occur from the northeast and east. This probably averages slightly over 25 percent of the time from the northeast and slightly under 25 percent of the time from the east. However, 5 percent of the time, waves approach from the east-southeast. Some degree of protection from northeast storms may be afforded by the Isles of Shoals about 15 miles northeast of the Merrimac River Entrance, and Cape Ann to the south may provide some protection from southeast storms.

b. Currents. An inspection of the 1967 U. S. Coast & Geodetic Current Tide Tables show that the maximum currents at the Merrimac River entrance do not exceed 2.2 knots. Other than the effects on sand movement in and out of the channel entrance and distribution and shaping of the outer bar at the entrance, these currents, which are confined to the channel, do not contribute to the erosion in the problem area.

c. Winds. A wind rose compiled from a 10-yr wind record for Logan Airport, Boston, Massachusetts, show that the prevailing winds blow offshore from the western quadrants. The winds blowing onshore across significant fetches to produce damaging waves are predominantly from the northeast through the southeast quadrants.

d. Storms. A study of records of the United States Weather Bureau at Boston, Massachusetts, shows a preponderance of gales (winds greater than 39 miles per hour) blow from the northeast direction. These storms are usually of long duration extending through several high tides, resulting in erosion of beach and backshore areas, with undermining and damage to or losses of structures and cottages.

e. Tides. The tides at Plum Island are semi-diurnal. The range of tide at the Merrimac River entrance at the North end of Plum Island is 8.0 feet and the spring range is 9.3 feet. The mean range of tide at the mouth of the Ipswich River at the south end of Plum Island is 8.7 feet and the spring range is 9.9 feet. Studies indicate that tides exceed the plane of mean high water by 2 feet or more once a year and by 3 feet or more once every 2 years. In 1944, a storm tide of 3.9 feet above mean high water was experienced at Portsmouth Naval Yard, which is located about 17 miles northerly of the study area.

9. Shore History.

a. Shoreline and offshore Changes. Detailed surveys and studies will be required to evaluate changes that have occurred since the previous beach erosion study was completed in 1952. Field inspections and discussions with local interests, however, indicate that the problem area as defined in the completed beach erosion control report, has extended alongshore, and eroded inland substantially. This area was originally defined as between points approximately 3000 feet and 6000 feet south of the south jetty at the Merrimac River. Now it appears that serious losses have occurred in variable degrees from the Plum Island Turnpike northward the entire 6000 feet to the south jetty.

The offshore bar extending south across the Merrimac River entrance is subject to continuous change and further complicates the complex erosion processes which affect the shorefront.

b. Prior Corrective Action and Existing Structures.

At the time of the completed beach erosion control study in 1952 there were no significant structures constructed solely for beach erosion control. The jetties at the entrance to the Merrimac River entrance completed in 1914 for navigation control are scheduled for rehabilitation in late 1967. Since the completion of the B. E. C. Report in 1952 the Commonwealth of Massachusetts in accordance with the approved plan contained therein, placed about 560,000 cubic yards of sand-fill during 1953, along the beach section starting at about the extension of Plum Island Turnpike and extending in a northerly direction for a distance of about 3000 feet. Subsequently, and between about 1954-1957 they constructed Groin Nos. 1, 2 and 3 to retard excessively high sand losses along this beach area. The groins south of the Plum Island Turnpike have been reported as being successful in accreting sand fill, however, north of the turnpike they have functioned less efficiently particularly in the northerly section. The State has rehabilitated two groin structures north of the Turnpike and added a limited amount of revetment along more seriously eroding backshore areas fronting the development in part of this northerly section. Private property owners have in some instances added revetment along eroding embankment fronting their property.

c. Profiles - Accretion & Erosion. There have been no recent profiles made for the Plum Island shore front. Field investigations including a rough check of elevations by hand level, indicate that the slope of the foreshore is quite steep, averaging between one vertical on ten or twelve horizontal. Field observations, combined with partial construction surveys made by the Massachusetts Department of Public Works on their limited protection work, has been utilized in estimating profiles for rough quantity estimates, in this reconnaissance study. These observations disclose that major changes have occurred since the 1953 shoreline survey was made. In many cases marked accretion has occurred at the south side of groin structures constructed since 1953 and serious erosion has been experienced on the north side. The southerly groins south of the Plum Island Turnpike are not affected in quite this way, however, being filled to capacity throughout. The groin structure at the Turnpike and the next two northerly structures show a marked differential accretion-erosion problem in this manner.

The two northerly groins next to the south jetty at the Merrimac River mouth, however, show very little differential accretion. In the area of these two groins they apparently show major offshore losses throughout. The area adjacent to and directly south of the south jetty is an area of accretion. Photographs 6, through 8 demonstrate this quite effectively. A more up to date evaluation cannot be made until surveys are obtained.

ANALYSIS OF THE PROBLEM

10. Preliminary Analysis of Shore Processes. The structure of this barrier beach contained between the Merrimac River on the North and Ipswich River on the south, lends itself to a constant movement of material from tidal wave erosion processes. It is subject to ordinary and storm wave induced processes throughout, complicated by the effects of tidal currents and associated offshore bar formations at the mouth of the Merrimac River. There is a tremendous available supply of beach building material along the southerly portion of the island, south of the Plum Island Turnpike. Here, the beach is wide, there are well developed dunes along the entire shore, and drumlins at the southeast end of the island. These dunes and drumlins show evidence of serious undercutting and losses throughout. There is some movement of material alongshore occurring each day under ordinary normal tide and wave conditions. During periods when beach building swells prevail, accretion apparently occurs to some degree throughout the entire length of Plum Island. During storms when the beach is overtopped, waves seriously erode the beach and backshore dunes and embankments. It appears that along the southern two thirds of the island, outside of the influence of the Merrimac River and offshore bar formation, where there is a large supply of available beach building material, a balance of along shore movement of material is approached. At the northern portion of the island, the problem area, waves are directed and concentrated by the shaping and configuration of the offshore bar. Material moving along this outer bar during northeast storms is not available to accrete at the groin structures along much of the shore north of the Plum Island Turnpike. This material is available, however, for accretion along the south shore or at the groins south of the Turnpike outside of the influence of the Merrimac River bar.

11. Method of Correcting Problem Conditions. There are several alternative methods of correcting the problem. However, a solution which is both practical and economically feasible must be utilized. The completed beach erosion study of Plum Island in 1952 considered many alternative solutions including offshore breakwaters, revetments, bulkheading, groin structures and beach widening. It was determined that for groin structures to be effective to build up the beach in the problem area, they would need to extend seaward to the outer bar to intercept material moving along the bar predominantly from the northeast during storms from that direction. Shorter groins might be effective in retarding losses from the beach. Although bulkheading or revetment might be effective to protect the backshore, these structures would not hold the fronting beach. Offshore breakwaters could be effective for erosion control but are extremely costly. The most practical and economically feasible method furnishing both erosion control and beach restoration is by direct placement of suitable sand fill within the problem area, with proper maintenance to assure its continued effectiveness. This may require a groin system for retention of sand fill, and increasing the height of the inner end of the south jetty to prevent sand washing from the beach into the Merrimac River. Consideration should be given to the relative cost of beach maintenance with and without a series of groins to retard alongshore movement of beach sand.

12. Design Criteria. The proposed method of protection is designed to furnish protection from the more frequent storms. Although it will not afford complete protection from the infrequent higher level storms, nevertheless it will provide a substantial degree of protection under such conditions. Pertinent design criteria is described below:

a. Design Tide. A design tide of 12 feet above mean low water is considered as the practical elevation of this area. This represents a tide level about 4 feet above normal high tide, which might be expected to occur about once in 20 years, although tides reach 3 feet or more above mean high water as frequently as once in two years.

b. Design Wave. The design wave utilized in the rehabilitation of the jetties was established as less than 3 feet for the seaward side of the inner end of the jetty to 15 feet at the outer end. These waves were selected by hindcast studies utilizing station "A" off Penobscot Bay and adjusting for the depth factor of 0.78 D as the maximum wave that can be supported where "D" is the water depth at the structure.

This same procedure was utilized for the design of the groins except a wave height of 12 feet was believed adequate for design of groins which are less exposed than the outer end of the longer jetty.

c. Sizes, and Slope of Armor Stones in Structures.

Since the top of the inner end of the existing jetty will only have to be raised a small amount (4 feet) this will be accomplished by utilizing the same requirements as prescribed in the design memorandum for rehabilitation dated October 1965. The existing groin structures, for one of the plans considered, would be extended to the toe of slope of the beach fill. The side slopes would be 1 vertical on 2 horizontal. The maximum weight of armor stone would be 6 tons placed on a $\frac{1}{2}$ ton underlayer with an inner core of assorted sizes giving impermeability.

d. Sand Fill. Natural beach berms with backshore elevations estimated at 13 feet above mean low water are subject to overtopping. A practical beach section considered more resistant to excessive erosion has been developed. The beach would be widened to a maximum of 150 feet from the face of dunes or revetment at elevations sloping from 15 feet above mean low water at the dunes to 12 feet above mean low water at the seaward edge of the berm and have seaward beach slopes of 1 vertical on 12.5 horizontal above mean low water and 1 vertical on 20 horizontal below mean low water. The beach fill can be placed on a slightly steeper slope above mean tide level and allowed to take its natural slope under wave action.

PRELIMINARY PLAN OF IMPROVEMENT

13. General. The plan of improvement selected for the area was found to be the most economical and practical solution for correction of the problem of all the alternative plans considered. It is generally in agreement with the findings of the prior beach erosion control study since the problem is essentially still the same, but is becoming progressively more extensive and serious. The plan also fulfills the desires and requirements of the local interests.

14. Description. The method of protection considered is as shown on plate 2 and consists of two alternative plans described as follows:

a. Plan 1. Beach widening along about 6000 feet of shore - front north of the Plum Island Turnpike by direct placement of sand fill with maintenance accomplished by periodic nourishment of sand fill. The inner end of the south jetty at the northern end of the improvement would be raised to 16 feet above mean low water.

b. Plan 2. Beach widening and raising of the inner end of the jetty as for Plan 1 but incorporating a groin system by extending existing structures if it is determined by detailed studies that losses are sufficiently reduced for justification of these retention structures. The maximum width of beach and berm design is established as a practical dimension commensurate with stable beaches within the area, however, recreational use requirements and other benefits become a major factor in determining the final dimensions of the improvement.

ECONOMIC ANALYSIS

15. General. Cost estimates are based on the prevailing 1967 price level.

16. First Cost. The first cost of the project is based on sand fill being obtained by pumping directly from within the nearby navigation channel at the Merrimac River, within the basin area, or from the outer bar. There is an abundance of suitable beach material in this offshore bar at the entrance to the Merrimac River and recently developed hopper dredge pump-out procedure and other economical methods of obtaining the material necessary to construct the project. The unit price of stone used in raising the jetty or in the groin construction is considered average for this area. The quantity of sand fill was determined from cross sections above high water line surveyed by the State of Massachusetts in January 1966 and are an approximation. A more extensive study would require more complete surveys. An itemized first cost of construction for the two plans of protection are tabulated below:

PLAN 1 Beach Fill and Periodic Nourishment

<u>Item</u>	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Estimated Amount</u>
Sand Fill	420,000	C. Y.	1.25	\$525,000
Raising Jetty	2,500	Tons	13.00	<u>\$ 33,000</u>
		Sub-Total		\$558,000
		Contingencies		<u>\$ 82,000</u>
		Sub-Total		<u>\$640,000</u>
		Engineering & Design		<u>25,000</u>
		Sub-Total		<u>\$665,000</u>
		Supervision & Admin.		<u>55,000</u>
		Total First Cost		<u>\$720,000</u>
Cost of Periodic Nourishment for ten years		\$75,000 per/yr for 10 years		<u>\$750,000</u>
		Total Construction Cost (including 10 year nourishment)		\$1,470,000

PLAN 2 Beach Fill and Groin Extension

<u>Item</u>	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Estimated Amount</u>
Sand Fill	420,000	C. Y.	\$ 1.25	\$ 525,000
Groin-Armor & Core stone	25,000	Tons	\$13.00	\$ 325,000
		Sub-Total		\$ 850,000
		Contingencies		100,000
		Sub-Total		\$ 950,000
		Engineering & Design		40,000
		Sub-Total		\$ 990,000
		Supervision & Admin.		100,000
		Total First Cost		\$1,090,000

17. Annual Charges. Federal and non-Federal interest is computed at the rate of 3-1/4 percent. A useful project life of 50 years is used for the determination of amortization charges. It is considered that in this area of rather intense wave activity periodic nourishment is required at an annual average rate of about 15 percent, or 60,000 cubic yards of beach nourishment annually without groins and about 30,000 cubic yards annually with groins.

For details of the annual charges of each plan see the tables below:

Annual Charges - Plan 1

Interest (0.3250) (720,000)	\$ 23,000
Amortization (0.00823) (720,000)	6,000
Nourishment 60,000 x b. y. \$1.25	75,000
Total Annual Charges	\$ 104,000

Annual Charges - Plan 2

Interest (0.0325) (1, 090, 000)	\$35, 000
Amortization (0.00823) (1, 090, 000)	9, 000
Nourishment 30,000 C. Y. @ \$1.25	38, 000
Maintenance Groins @ 1% Construction Cost	11, 000
Total Annual Charges	<u>\$93, 000</u>

18. Annual Benefits. The benefits attributed to an improvement are based on increased recreational use of the beach, direct damages prevented and land enhancement. With more people gainfully employed than ever before and with more leisure time at their disposal, going to the beach is one of the most popular forms of outdoor recreation in New England. The northern shore of Massachusetts is well known for its beaches and recreational facilities. Although Plum Island Beach does not receive the usage that Salisbury and other beaches in the vicinity receive, this is due mainly to the lack of public use facilities at this location. If features, such as parking facilities, access to the beach at convenient locations, sanitary facilities and an attractive beach are provided, Plum Island Beach will not only receive the overflow from adjacent beaches but many people will make this beach their main destination.

If a dry beach of 150 feet width lying above the plane of high water is provided, this will create an area of 900, 000 square feet of beach. The desirable area of 75 square feet per person would allow for 10, 000 people to use this beach at one time. It is generally accepted that there will be a turnover of two during a day or in other words a peak day capability of 20, 000 attendance. It does not appear unreasonable to assume with the provision of the necessary facilities that on peak days this attendance would occur. EM 1120-2-108 states that an average value of \$0.50 per visit may be considered appropriate for a publicly owned, partially developed beach. The present beach has capacity for 6000 people which is considered to be adequate for week day use at one time. It is estimated that there would be 20 peak days during the recreational season. On this basis the recreational benefit is computed at $6000 \times 2 \times \$0.50$, or an annual value of \$120, 000.

19. Recent history has shown Plum Island to be subject to destructive storms with subsequent loss of protective beach. Recession has reportedly reduced the width of lots seaward of Northern Boulevard from widths of 190 to 260 feet in 1920 to 40-50 feet to date. Storm attack has damaged or destroyed cottages located on sand dunes and has necessitated the repeated moving of buildings landward. At the present time, cottages are located close to Northern Boulevard and there is no space left for further movement. It is estimated that damage to property averages \$25,000 a year due to exposure to coastal storms and that this could be eliminated with the provision of a protective beach.

20. The shore property value would also be substantially enhanced by the construction of a protective beach. It is believed with the elimination of the threat of destruction of property that cottages would be improved or replaced with more costly structures. The nearby recreational beach would also increase the demand for rental property causing a more rapid turnover and an increase in property returns. It is estimated that an annual property enhancement benefit of at least \$25,000 would be realized.

21. The total benefits attributed to an improvement are listed as follows:

(a) Recreational	\$120,000
(b) Damage prevention	25,000
(c) Land enhancement	25,000
	<hr/> \$170,000

22. Justification. The estimated annual benefits and costs and the resulting ratio of benefits to costs for the project for each plan are given below:

<u>PLANS</u>	<u>Estimated Annual Benefits</u>	<u>Estimated Annual Costs</u>	<u>Ratio of Benefits to Costs</u>
Plan 1	\$170,000	\$104,000	1.6
Plan 2	\$170,000	\$ 93,000	1.8

23. Apportionment of Costs. The Federal investment cost is based on policy of Federal aid in the restoration and protection of shores against erosion as set forth in Public Law 826, 84th Congress, as amended and supplemented by Public Law 87-874 of the River and Harbor Act of 23 October 1962. Under that law, Federal participation in the cost of construction of protective works along publicly owned shores is authorized up to one-half of the cost, except in the cases of certain parks and conservation areas. Privately owned shores are eligible for Federal aid if there is a benefit such as that arising from public use or from the protection of nearby public property, or if the benefits to the shores are incidental to the project, and the Federal contribution to the project is adjusted in accordance with the degree of such benefits. Although the shorefront is presently generally privately owned, a local program has been started to convert the shore to public ownership. The means by which local interests would establish a public beach along this privately owned shorefront would be by deeding all land seaward of an established line to the municipalities. In addition local interest would be required to provide adequate access and necessary facilities for the public. The apportionment for each plan adjusted to reflect the degree of public benefits and allowing for 1000 feet of Federal property is tabulated as follows:

* Apportionment of First Cost (Based on public ownership of entire beach)

<u>Item</u>	<u>First Cost</u> <u>Subject to</u> <u>Apportionment</u>	<u>Non-Federal</u> <u>Percent</u>	<u>Amount</u>	<u>Federal</u> <u>Percent</u>	<u>Amt</u>
Plan 1	\$ 720,000	55	\$ 396,000	45	\$324,000
Plan 2	\$1,090,000	55	\$ 600,000	45	\$490,000

* Apportionment of Annual Nourishment and Maintenance Cost
(Based on Public Ownership of Entire Beach)

<u>Item</u>	<u>Annual Cost</u> <u>Subject to</u> <u>Apportionment</u>	<u>Non-Federal</u> <u>Percent</u>	<u>Amt</u>	<u>Federal</u> <u>Percent</u>	<u>Amt</u>
Plan 1 Nourishment	\$75,000	55	\$41,000	45	(1) \$34,000

Plan 2

Groins

Maintenance	\$11,000	100	\$11,000	0	0
Nourishment	<u>38,000</u>	100	<u>\$38,000</u>	0	0
Total	\$49,000		\$49,000		

(1) This Federal share of periodic nourishment would be for the first 10 years of project life after which benefits and techniques would be reevaluated.

* The total Federal share in cost participation on the Section 103 Small Beach Erosion Control Project Authority is limited to \$500,000 including costs of periodic nourishment. The Non-Federal Cost of Plan 1 under Section 103 would be \$970,000 including Periodic nourishment and for Plan 2, \$600,000 and \$49,000 annual maintenance for the lifetime of the project.

24. Local Cooperation. The preliminary estimate of the first cost of the project to be borne jointly by the United States and local interests is roughly estimated to be \$720,000 for Plan 1 without groins or \$1,090,000 for plan 2 with groins depending on which plan proves to be the most feasible in a detailed study. In addition to the initial construction cost, the cost of periodic nourishment for an initial period of 10 years is estimated at \$75,000 annually for Plan 1 and the cost of maintenance of the groins and periodic nourishment for plan 2 is estimated at \$49,000 annually for the lifetime of the project. The Federal share of project cost is expected to be the maximum allowable for public shores contingent upon all land seaward of an established line being deeded over to the municipality for public use. The Federal share of the cost (and including periodic nourishment for Plan 1) under Section 103 is \$500,000, thus the Non-Federal share of the cost for Plan 1 would be \$970,000 including \$75,000 annually for beach nourishment for the initial 10 year period. For Plan 2 the Federal share is \$490,000 and the non-Federal share is \$600,000 plus \$49,000 annually for maintenance for the lifetime of the project.

25. The recommended Federal participation is subject to the conditions that local interests will:

a. Assume responsibility for all project costs in excess of \$500,000 to insure that expenditure of Federal funds will result in a complete and fully effective project. The Federal cost limitation includes costs for all investigations, planning, design, supervision, or administration involved in the development and construction of the project, including Federal costs for periodic nourishment.

b. Assure continued public ownership or continued public use of the shore upon which the amount of Federal participation is based, (the deeded shorefront property) and its administration for public use during the economic life of the project.

c. Assure maintenance and repair during the economic life of the works as may be required to serve the intended purpose, with Federal assistance on periodic beach nourishment for Plan 1.

d. Provide at their own expense all necessary land, easements and rights-of-way.

e. Hold and save the United States free from claims for damages that may result from construction or maintenance of the improvement.

f. Assure that water pollution that would endanger the health of bathers will not be permitted.

g. Provide, at no cost to the Federal Government, all necessary appurtenant facilities as may be required for full realization of the recreational benefits, such appurtenant facilities presently considered to be

- (1) Additional parking areas
- (2) Sanitary facilities
- (3) Beach access areas
- (4) Bath House

26. Coordination with and Comments of Other Agencies and Local Interests.

Appendix B presents copies of letters pertinent to the preparation of this report. These letters demonstrate the deep concern shown by State and local interests in the problem. Other letters from Congressmen and Senators have continually expressed their concern. Meetings have been held with State and local interests to discuss the problem particularly in regard to quit-claiming of property seaward of an established line for public use. The willingness of property owners in deeding over property for public use is demonstrated by their reaction in the meeting of 1 September 1966 as described in the letter of 11 September 1966 from Mr. Raymond Walton, Chairman of the Beach Erosion Committee, Plum Island Taxpayers Associates Inc. Mr. Walton orally stated that one hundred percent participation in required land acquisition may be anticipated at the time of construction of a project. The City of Newburyport, jointly with the Town of Newbury in their letter of 27 September 1966 in commenting on the meetings, indicate a favorable reaction toward this procedure.

27. Conclusions. The Division Engineer concludes that the erosion problem at Plum Island is an extremely critical situation with a serious loss of shorefront property occurring during frequent storms jeopardizing several cottages previously moved inland. He also concludes that with the present and future demand for recreational beaches that with proper deeding over of beach property for public use, an economically feasible beach erosion control improvement could be developed.

28. Recommendations The Division Engineer recommends that a detailed Beach Erosion Control Report be prepared to determine the most economical and practical beach erosion control improvement for Plum Island, Massachusetts, pursuant to the Small Beach Erosion Control Project Authority provided by Section 103 of the 1962 River and Harbor Act. The Division Engineer further recommends that because of the urgency of the problem \$40,000 as estimated in Appendix "C" be allotted to New England Division as soon as possible for preparation of the Detailed Project Report, estimated to take about 1.5 years.



PHOTO 1. 13 Sept. 1966. Drumlin at southeast corner of island - note good vegetation - no erosion southeast side.

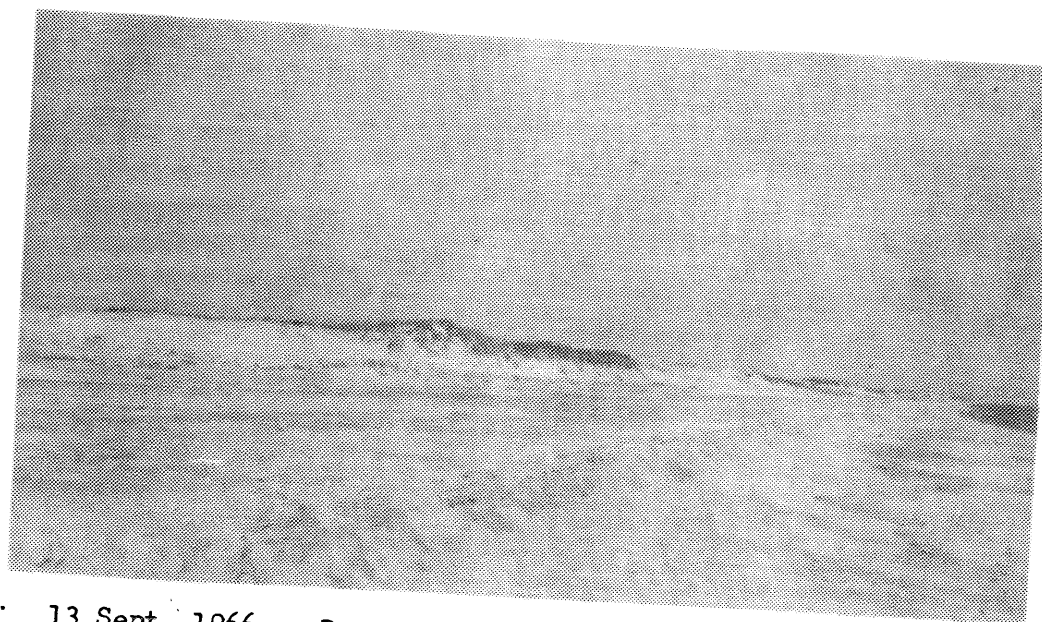


PHOTO 2. 13 Sept. 1966. Dunes along southern portion of island - note 100 feet wide beach berm.



PHOTO 3. 12 Sept. 1966. Looking north from Turnpike Groin.



PHOTO 4. 12 Sept. 1966. Revetment construction by State north of Groin 2. Note normal tides approach toe of mound.



PHOTO 5. 12 Sept. 1966. Shorefront north of Groin 3 - Serious erosion throughout.

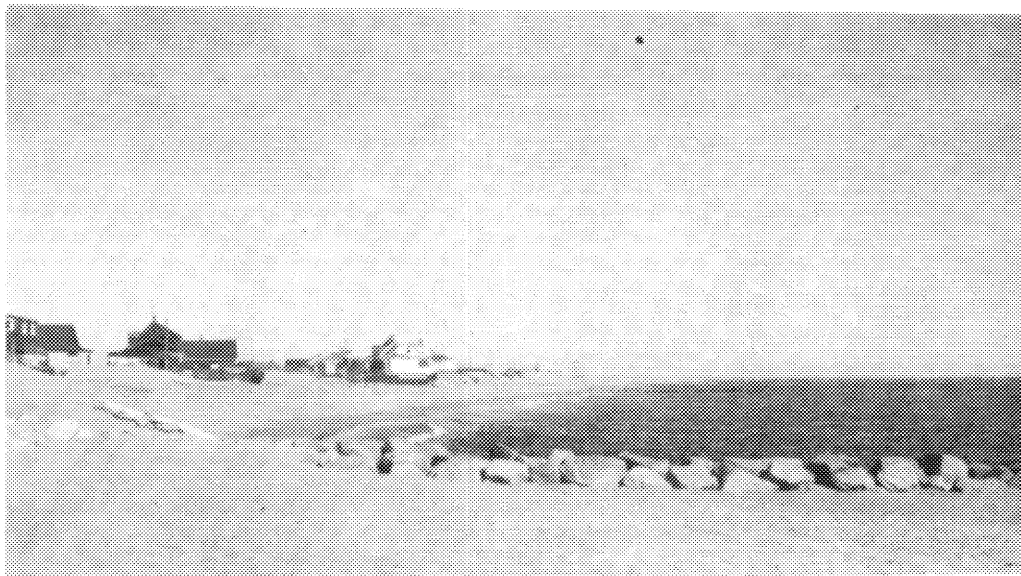


PHOTO 6. 12 Sept. 1966. Groin 3 - Note erosion to north, accretion southside.



PHOTO 7. 12 Sept. 1966. Groin 4- Note = Erosion to north, accretion southside.



PHOTO 8. 12 Sept. 1966. Groin 5 - Looking north toward Jetty.



PHOTO 9. 12 Sept. 1966. Riprap revetment fronting cottage south of Groin 3.

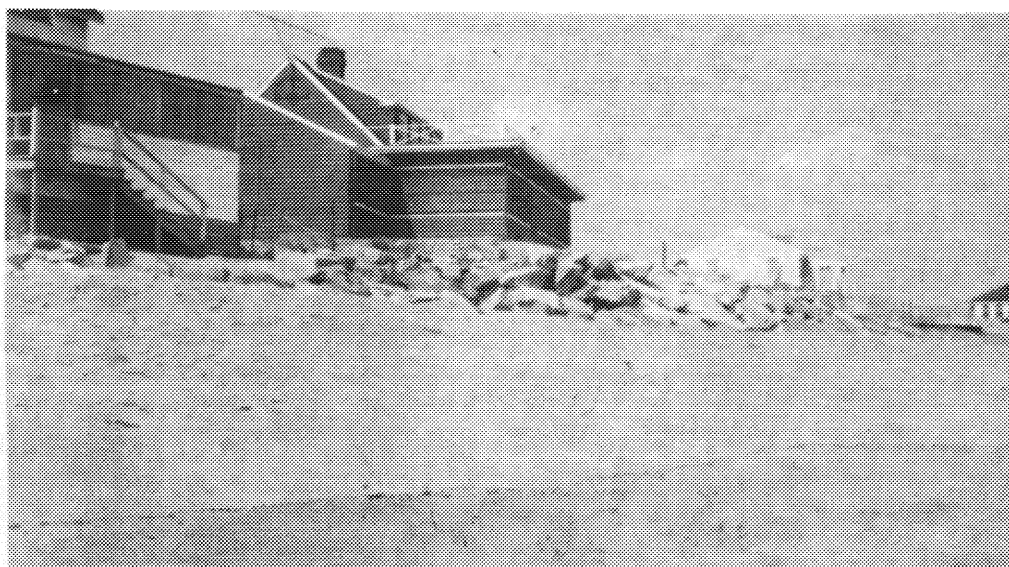


PHOTO 10 12 Sept. 1966. Rip rap revetment fronting cottage south of Groin 4.

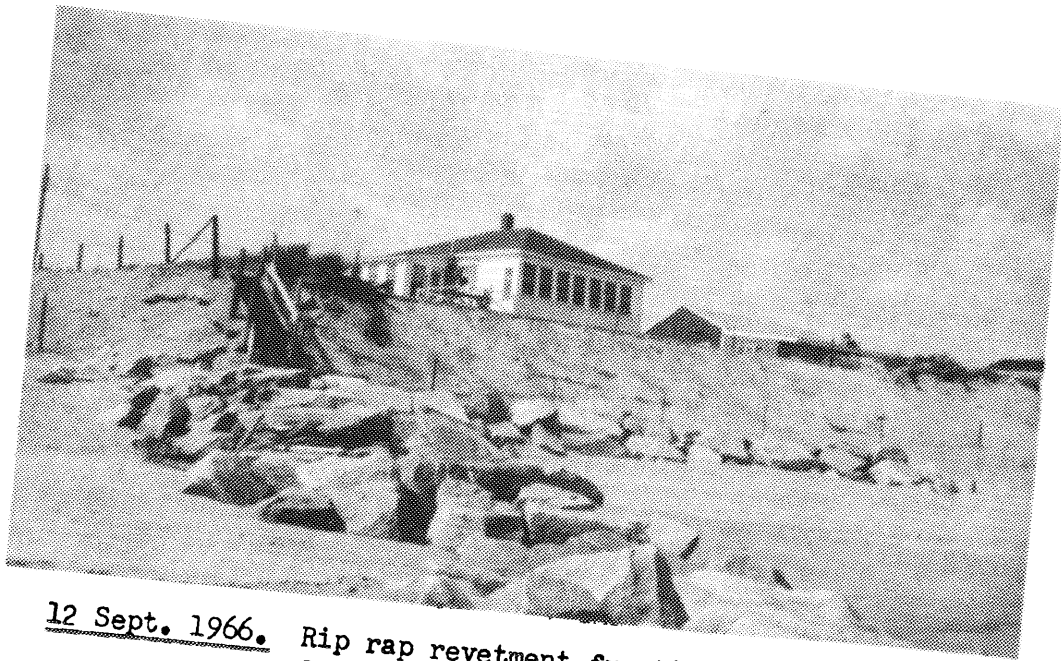


PHOTO 11 12 Sept. 1966. Rip rap revetment fronting cottage north of
Groin 4 - This revetment frequently overtopped.

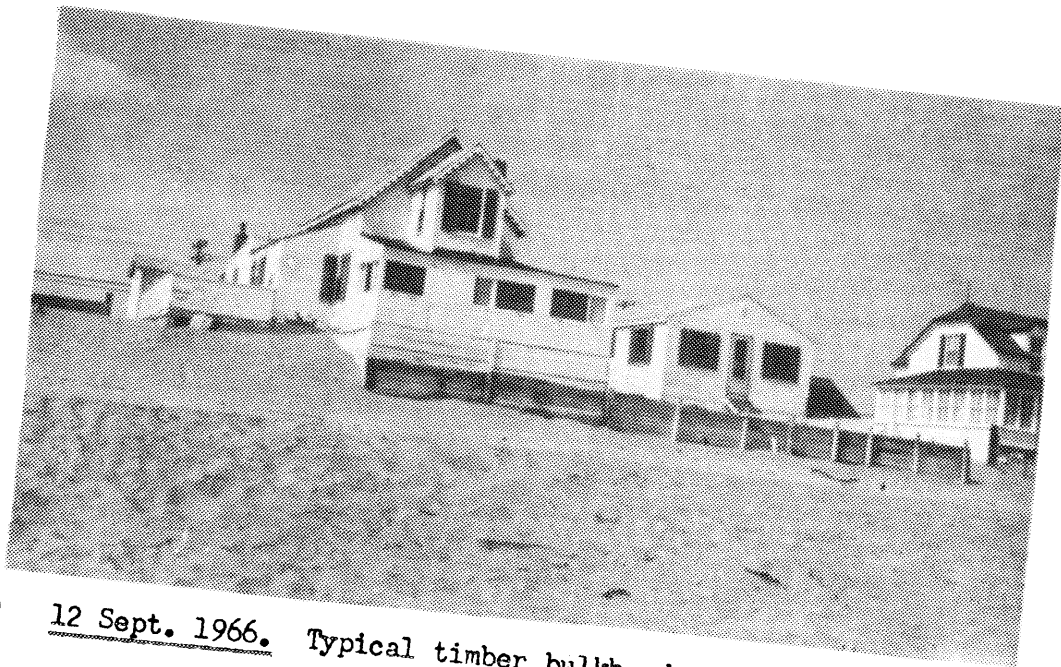


PHOTO 12 12 Sept. 1966. Typical timber bulkhead.

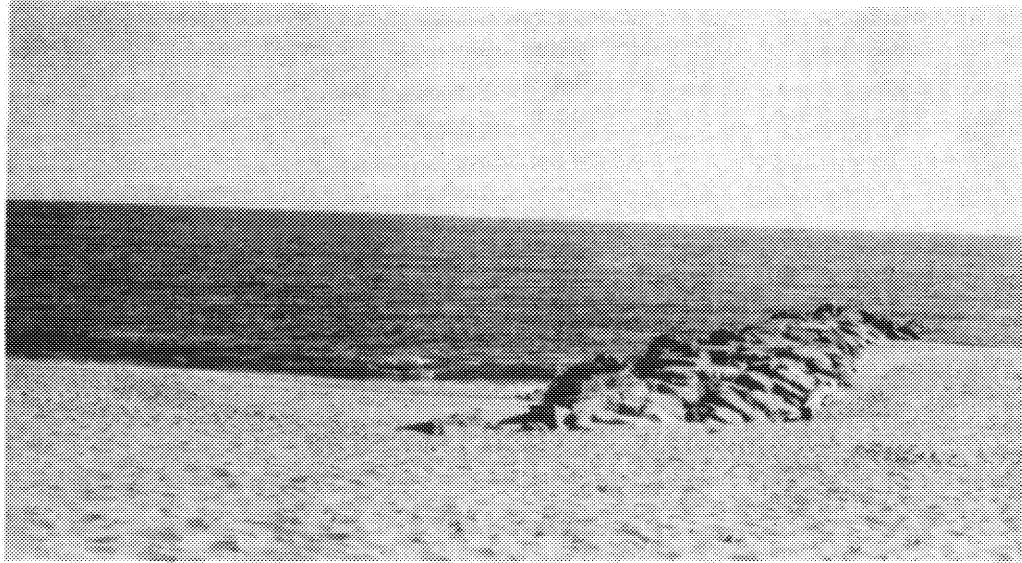


PHOTO 13 12 Sept. 1966. Turnpike Groin. Note erosion on north side.
Accretion southside.



PHOTO 14 12 Sept. 1966. Groin 3. Note erosion on north side, substantial
accretion south side.

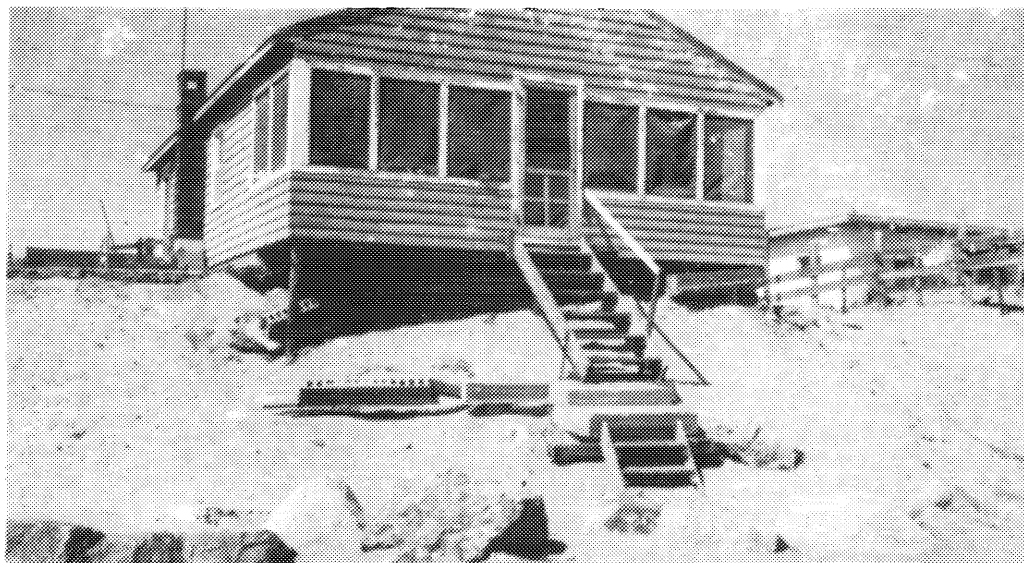


PHOTO 15 July 1966. Cottage undermined by storms near Groin 5.



PHOTO 16 12 Sept. 1966. Groin in need of repair - demonstrates wave damage.



PHOTO 17 12 Sept. 1966. Remains of cottage foundation. North of roin 4.
Several cottages lost in this area.

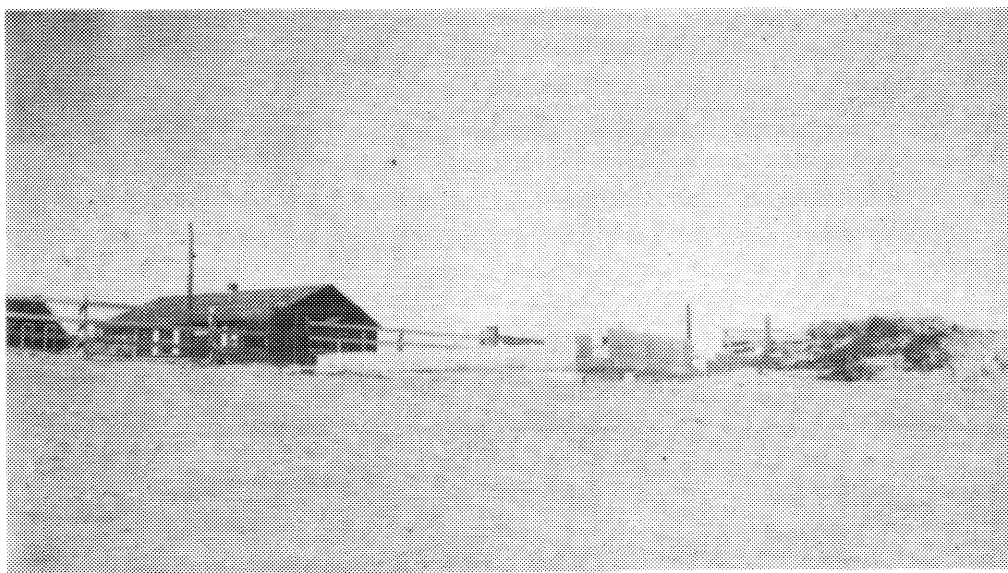


PHOTO 18 12 Sept. 1966. Remains of cottage foundation. Northerly problem
area. Cottages have been relocated inland.



PHOTO 19 15 Sept. 1966. Looking north from Groin 3 during minor northeast storm.



PHOTO 20. 15Sept. 1966. Looking north from Groin 4 during minor northeast storm.

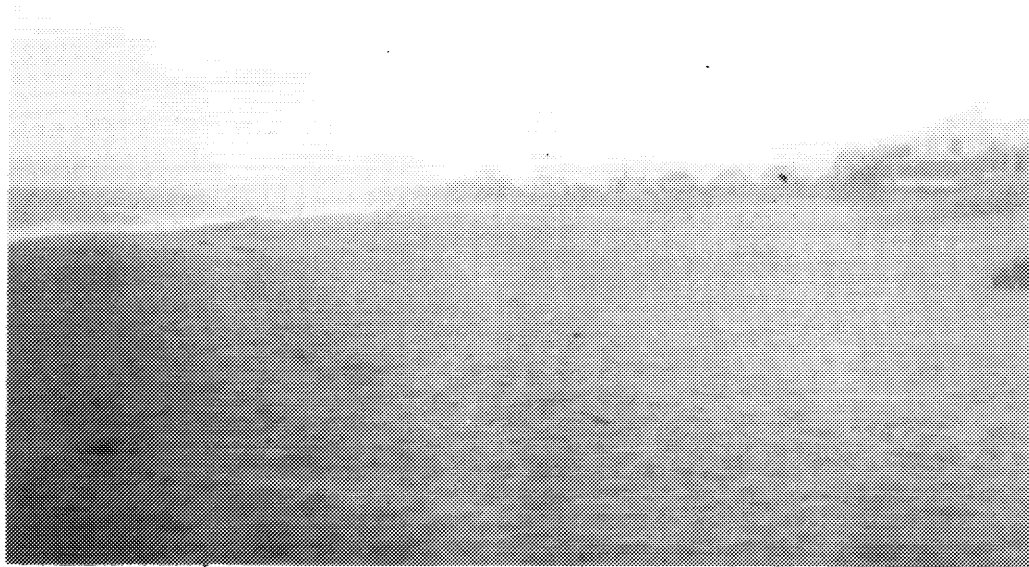


PHOTO 21 15 Sept. 1966. Looking south from Turnpike Groin during minor northeast storm. Note substantial beach width.



PHOTO 22 15 Sept. 1966. Revetment construction by State north of Groin 2 during minor northeast storm



PHOTO 23 15 Sept. 1966. Groin 3 during minor northeast storm. Note erosion action northside



PHOTO 24 15 Sept. 1966. Looking south towards Groin 3 during minor northeast storm.

APPENDIX A

Physical Description Problem Area

1. A brief description of the physical aspects of the problem area as determined from field inspections is presented. The major problem area is from the groin structure at the Plum Island Turnpike to the south jetty at the entrance to the Merrimack River. The problem becomes increasingly serious in a northerly direction except in the vicinity of the jetty. The area south of the Turnpike has a wider protective beach and local interests state their opinion that there is no problem in that southerly area. Photograph 21 portrays this quite realistically as it shows storm waves breaking some distance seaward of the development as compared to other photographs 19, 20, 22, 23 and 24 showing more serious conditions along the northern problem area. For descriptive purposes the groin structures in the problem area are numbered consecutively to the north from groin 1, the turnpike groin. A description for each section of shore between groins northerly of the Turnpike structure to the south jetty is described as follows:

a. Turnpike groin (no. 1) to groin 2 (includes general description of southerly developed area). Estimate 150 feet differential beach width buildup at this groin structure (accretion on south side, erosion immediately to the north). The beach is estimated about 6 feet higher on the south side seaward of the projected normal high water line on the north side. The beach, fronting the development to the south, slopes landward about 180 feet from normal high tide to about 13 feet above mean low water at the base of dunes. The development consists, in general, of well maintained cottages or homes located at the top of vegetated dunes. Between this groin and groin 2 to the north the beach averages 50 to 100 feet wide from normal high tide to base of sloping vegetated dunes. The base of the dunes is estimated at elevation 13 feet above mean low water and the dunes rise well above storm tides. There is one "snack bar" and private parking lot immediately landward of groin 1. Cottages between groin 1 and groin 2 are in general at top of dunes, or some distance back or behind dunes entirely. See photograph 3 looking along this shorefront.

b. Groin 2 to Groin 3. There is a seriously eroding section of beach immediately north of groin 2 (about 300 feet). A differential beach widening of about 160 feet occurs as accretion at the south side of this groin. The beach is estimated to average 6 feet higher on the south side seaward of the projected normal high waterline. The backshore area between these groins consists of segments of steep embankments or bulkheads. The beach for 200 feet north of the groin is less than 40 feet wide above mean high water to the toe of embankment then widens averaging about 75 feet wide to toe of embankment or face of raised cottages or bulkheads above mean high water to groin 3. Cottage development is either at top of exposed and eroding embankment or at lower back shore elevations with cottages raised, bulkheaded, or reveted and subject to frequent wave attack. Groin 2 has been repaired by the State and the construction of a low stone mound for about 300 feet to the north has been completed as part of the State's remedial work for the area. See Photograph 4 for this area.

c. Groin 3 - Groin 4. Estimate 170 feet differential beach width build-up occurring as accretion on south side with serious erosion occurring throughout to the north. The beach is estimated to be 8 feet higher on the south side seaward of the projected normal high waterline on the north side of groin 3. Even with the increased width at the south side, a cottage located adjacent to and immediately south on a high projecting bank has costly bank revetment, which is subject to frequent undermining and imminent failure from wave action occurring during storms (see photographs 6, 9 and 14). This section of shore and adjacent areas to the north is where intensive erosion has occurred and is continuing. It was reported that with the construction of groin 3, this section and northerly areas immediately experienced a rapid increase of erosion resulting in losses of cottages and the necessity of moving several inland. The normal high tides approach or are at the base of embankment bulkheads or revetment. The beach is steep throughout and the higher embankments are sloughing and approaching this slope. Although some cottages have been moved inland, they are at the top of exposed and eroding embankments or back of bulkheads or revetments and subject to imminent loss from wave attack occurring during storms. See photographs 5-6-19-23 and 24, which portray the problem in this area.

d. Groin 4-Groin 5. This is a continuation of the same problem as occurs between groins 3 and 4 with normal high tides approaching or at the toe of the embankment. Several cottages have been reported as being lost in this area and several have been moved inland to the limits of the property. One cottage adjacent to groin 5, to the north, projects out over the top of the undermined embankment, and gravel fill has been dumped in front of one adjacent cottage. In this deteriorating and exposed area the gravel fill will afford little or no protection against a moderate storm: See photographs 7-10-11-17-18-20 which apply to this area.

e. Groin 5-Jetty. This area shows no differential accretion at groin which is loose and deteriorating allowing free passage of drifting sand. The shore front north from the groin consists of low undercut dunes with the beach widening out to several hundred feet at the south jetty. Most of this area is owned by the United States Coast Guard except for a small distance adjacent to the groin. Here, there is a permanently located mobile home on a block foundation at the top of the dune and a small cottage some distance inland and north of the groin. See photographs 8 and 15 which apply to this area.



Office of the Mayor
CITY HALL
CITY OF NEWBURYPORT
MASSACHUSETTS

GEORGE H. LAWLER, JR.
Mayor

July 12, 1966

Remi O. Renier
Colonel, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Renier:

Pursuant to a meeting held at Plum Island on July 11, 1966 with the Plum Island Beach Erosion Committee, Mr. Wentworth of your office and other State, City and Town representatives. We the undersigned Mayor of the City of Newburyport and members of the Board of Selectmen of the Town of Newbury, being the chief executive officers of the respective City and Town, request the U. S. Army Corps of Engineers to immediately undertake a study of the shore erosion problem, as it exists at Plum Island beach in the City of Newburyport and the Town of Newbury, under authority of a 103 Study.

This request is made in accordance with procedure for small Federal beach erosion projects.

Very truly yours,

Richard H. Knight
Chairman, Board of Selectmen
Town of Newbury

George H. Lawler, Jr.
George H. Lawler, Jr.
Mayor, City of Newburyport

Henry E. Webb Jr.
Member, Board of Selectmen

[Signature]
Member, Board of Selectmen



APPENDIX B
Pertinent Letters

The Commonwealth of Massachusetts

Department of Public Works

Office of the Commissioner

100 Nashua Street, Boston 02114

July 19, 1966

Remi O. Renier, Colonel
U. S. Army, Corps of Engineers
New England Division
424 Trapelo Road
Waltham, Massachusetts 02154

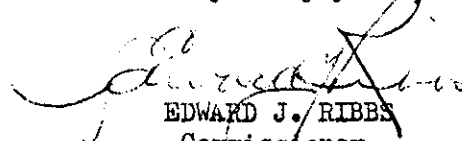
Dear Colonel Renier:

Thank you for your letter, dated July 15, 1966, in which you related the proceedings of the meeting which was held with the Plum Island Taxpayers Association on July 11, 1966.

I feel that this is a step in the right direction and can assure you that if these people want a Section 103 project, or one specifically authorized by Congress; and are willing to write off their shorefront rights, this Department will support such a plan. This appears to me to be the only approach to a solution of this problem.

We shall be pleased to meet with you at your convenience to further discuss this matter. Will you kindly have a member of your staff contact Deputy Chief Engineer Hannon at 727-4798 and set a date and time for same?

Very truly yours,


EDWARD J. RIBBES
Commissioner

APPENDIX B
Pertinent Letters

270 Main Street
Mt. Waco, Mass. 01860
September 11, 1966

Col. Henri O. Henier
Acting Division Engineer, M.E.
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, 54, Mass.

Dear Sir:

This is a report on the meeting at the Plum Island Taxpayers and Associates Hall on Sept. 1, 1966, with ocean front property owners to determine their attitude towards voluntary ceding over lots seaward of a line (the details to be determined later) to the City of Newburyport and the Town of Newbury to assure public use of any beach restored as a result of a Federal project under Section 103 authority.

The details of the matter are as follows:

1. There are 90 publicly owned front lots from the Coast Guard property to the town property at the south end.
2. Owners of 50 of these lots were present at the meeting with 2 others represented by friends who were to report to the owners on the meeting.
3. Exact total tally:


90 lots total	13 not no *
52 represented	2 represented owner
36 yes	1 no
4. A tally of owners North and South of the Plum Island Turnpike was made as follows:

North End	South End
60 lots total	30 lots total
36 represented	16 attended
29 yes	7 yes
4 not no *	9 not no*
2 represented owner	
1 no	0 no

* indicates there were various comments as to the ramifications of the project; e.g., would there be multistory bathhouses built on the beach in front of existing dwellings; would they expect us to give the land in anticipation of the project 1 or 2 years in advance, and things of that nature.

The one party that voted no will be contacted to make sure that they understand what they voted no to; however, the overwhelming majority of yeses or probables clearly indicates the property owners' willingness to cooperate with anyone who offers some hope for a solution to this problem.

Yours very truly,


Raymond H. Walton, Chairman
Beach Erosion Committee
Plum Island Taxpayers & Associates, Inc.

APPENDIX B
Pertinent Letters



Office of the Mayor
CITY HALL
CITY OF NEWBURYPORT
MASSACHUSETTS

GEORGE H. LAWLER, JR.
Mayor

September 27, 1966

Colonel Remi O. Renier
Acting Division Engineer, N. E.
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Renier:

Pursuant to previous meetings with representatives of the U. S. Army Corps of Engineers, Federal, State and local officials on a 103 Study for a Federal beach project along Plum Island, the City of Newburyport and the Town of Newbury, jointly, request that you proceed with this study.

Based on a report of a meeting held on September 1, 1966 with ocean front property owners, and a report of the meeting attached, it now appears that a great majority of these people involved wish to cooperate. On this basis the City of Newburyport and the Town of Newbury would be prepared to take deeds to these lots from the respective owners and to turn the property taken into a public beach facility, in compliance with law.

Very truly yours,

Richard H. Knight
Chairman, Board of Selectmen
Town of Newbury

George H. Lawler, Jr.
George H. Lawler, Jr.
Mayor, City of Newburyport

Henry E. White
Member, Board of Selectmen

James G. Moore
Member, Board of Selectmen

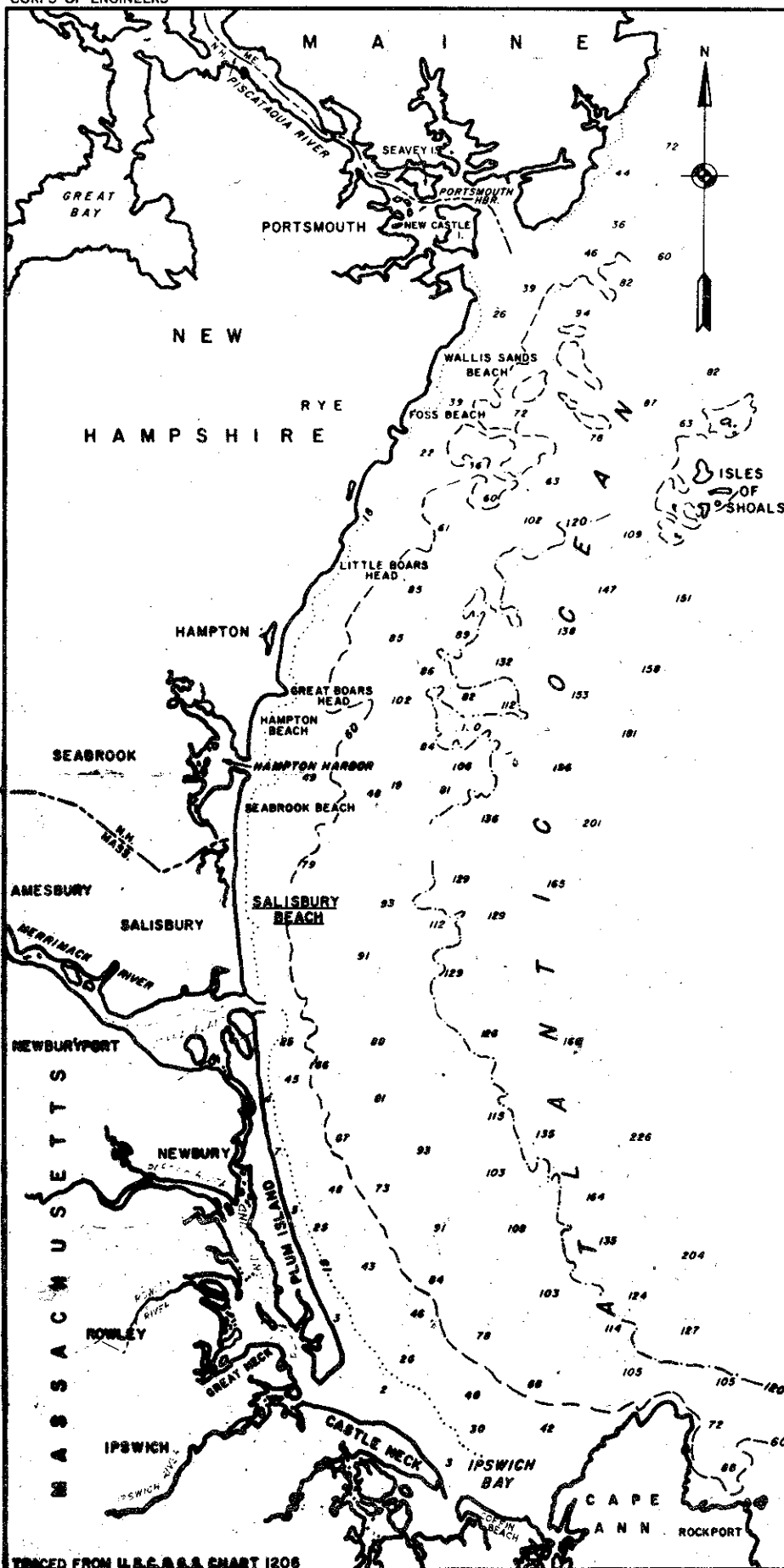
APPENDIX C

PLUM ISLAND, MASS.

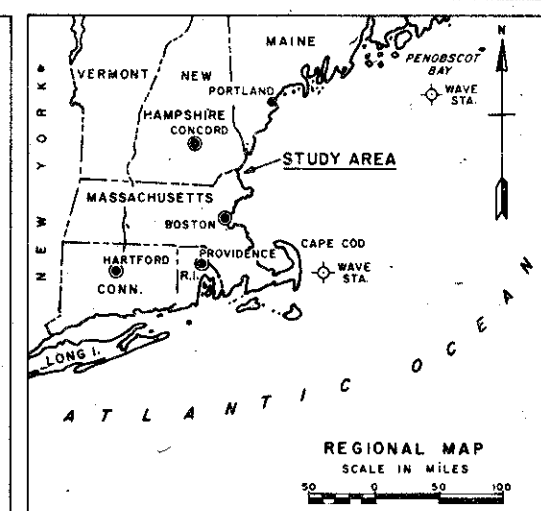
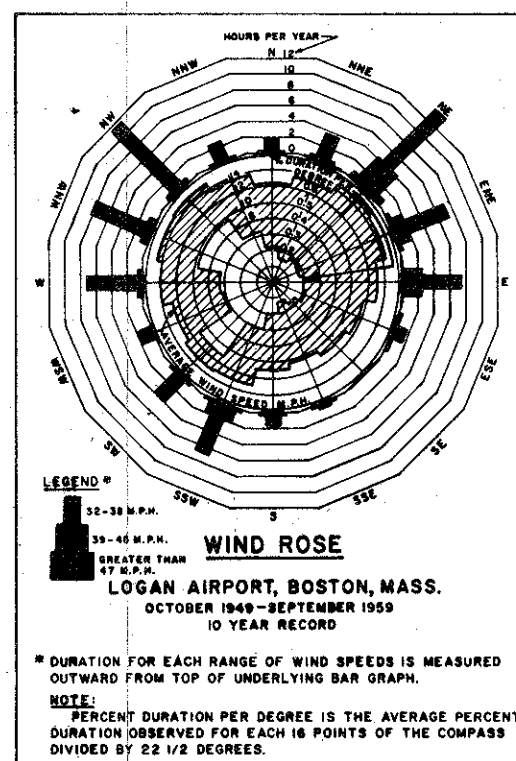
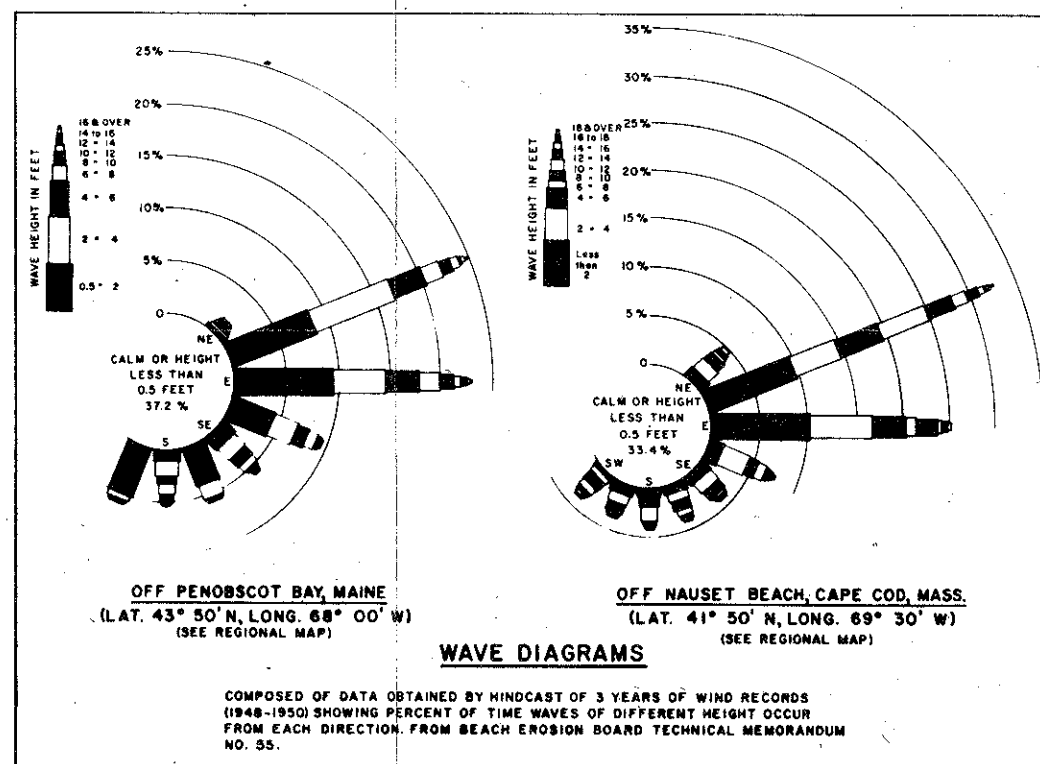
Small Beach Erosion Control Project

Estimated Cost of Detailed Project Report

Preliminary Planning and Public Contacts Including Reconnaissance Report	\$5, 000
Hydrology Studies	0
Surveying and Mapping	\$6, 500
Materials & Foundations Investigations	5, 000
Stream Regulation Studies	0
Design & Cost Estimates	7, 000
Economic Studies	5, 000
Real Estate Studies	2, 000
Special Studies	0
Preparation of Report	5, 000
Supervision & Administration	<u>4, 500</u>
TOTAL	\$40, 000



TRACED FROM U.S.C. & G.S. CHART 1205



BEACH EROSION CONTROL STUDY
OF PLUM ISLAND, MASS.
LOCATION MAP
SCALE IN FEET
0 10000 20000
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
FILE NO. BE. Pm. 14. 13 OCTOBER, 1957

